WindSat

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LONG-TERM GOALS

WindSat is a polarimetric microwave radiometer developed by the U. S. Navy in a partnered program. The Chief of Naval Operations (CNO(N6)), the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO), and the Space Test Program (STP), a DoD activity under the executive management of Air Force, are sponsors for the WindSat development, integration, launch, on-orbit operations, data analysis and distribution, and technology transfer. The Air Force Titan Spacecraft Procurement Office is providing the Titan II launch vehicle. CNO(N6), ASN(RD& A), and NPOESS IPO designated the Office of Naval Research (ONR) as the Department of the Navy's Program Manager for WindSat. The Director of ONR's Naval Space Science and Technology Program Office is the program manager. The Naval Research Laboratory provides technical project management and is developing, building and testing with other contractors, the WindSat payload, which consist of the radiometric sensor and associated algorithms. WindSat will be launched in August 2002 on the STP Coriolis Mission to demonstrate multiple Naval remote sensing requirements including measuring ocean wind speed and direction. WindSat will illustrate the

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viability of using polarimetry to measure the wind vector from space and provide operationally usable tactical information directly to Navy units and other military and national users. The payload provides risk reduction data and developmental technology that the NPOESS IPO will use in the development of the Conical Microwave Imager Sounder (CMIS).

OBJECTIVES

The WindSat payload is a multi-frequency polarimetric radiometer nominally operating at 6.8, 10.7, 18.7, 23.8, and 37GHz. Using a conically scanned 1.83 m offset parabolic reflector with multiple feeds, WindSat will cover a 1025 km active swath (based on an altitude of 830 km) and provide both fore and aft views. The horizontal ground resolution is determined by the size of the antenna and the altitude. The relatively large WindSat antenna will result in spatial resolutions approximately three times greater than current systems, improving the utility of the imagery data and enabling better measurements in the littoral. The 10.7, 18.7, and 37.0 GHz channels are fully polarimetric; that is, they derive all four Stokes parameters by measuring the six principal polarizations. The 6.8 GHz channel is dual polarimetric (vertical and horizontal) and provides sea surface temperature as a secondary product. The 23.8 GHz channel is also dual polarimetric because its purpose is to correct for atmospheric water vapor which is unpolarized.

Capability	NPOESS IORD	WindSat
Horizontal Resolution	20 km	25 km
Mapping Accuracy	5 km	5 km
Measurement Range	3 to 25 m/ s, 0 to 360°	3 to 25 m/ s, 0 to 360°
Measurement Precision Speed Direction	 1 m/ s 10°	 1 m/ s 10°
Measurement Accuracy Speed Direction	 Greater of ±2 m/ s Or ±20% ±20°	 greater of ±2 m/ s or ±20% 3 to 5 m/ s: ±20

Figure 1. Comparison of Requirement to Capability

APPROACH

Polarimetric radiometry characterizes the polarization properties of the surface emission by measuring the radiometric Stokes vector. Multiple airborne experiment campaigns have demonstrated that the microwave emission from the ocean surface varies not only as a function of wind speed, but also the wind direction. Stokes vector measurements from these campaigns have been used to retrieve the ocean surface wind vector.

Figure 2. Feed Horns in Flight Feedbench

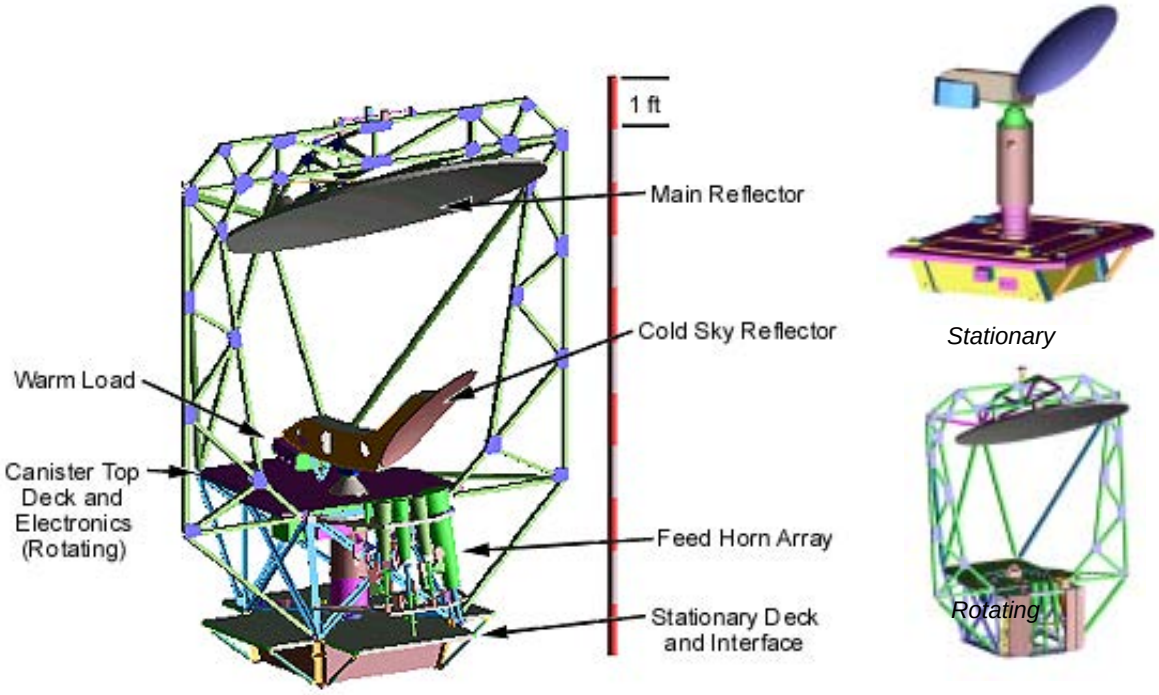

Figure 3. WindSat Payload and Components

WORK COMPLETED

The WindSat payload has been assembled and is undergoing integration and testing, space flight testing, and verification and interface testing with the Coriolis spacecraft bus at the Naval Research Laboratory.

Simulations of the environmental data record processor has been successful in retrieving wind vector, atmospheric water vapor and sea surface temperature. These retrievals are being used in testing over large geographic regions (tropics to polar). The ground processing team is currently evaluating the

most efficient method for selecting a priori state vector and working with the antenna range team to develop the technique for cold sky reflector pattern measurements and obscuration measurements.

Verification of several components, including receiver design and performance requirements, the capability to calibrate the WindSat antenna system, the antenna pattern modeling, the structural truss multipath impacts, and the feedhorn design and the off-axis positioning performance impact was completed at the Far-Field Range in Melbourne, Florida.

Flight unit fabrication, component integration and test, and detailed documentation of the payload and payload interfaces to the DoD/STP Spectrum Astro spacecraft are complete. NRL and its contractors are developing the retrieval algorithms that reduce the environmental data records to determine the ocean surface wind vectors, supporting integration with the spacecraft, launch, and flight operations.

Figure 4. WindSat Testing

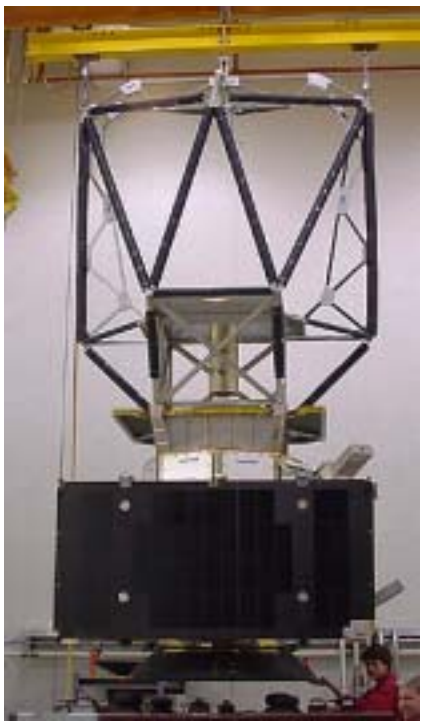

Figure 5. Testing with Coriolis Spacecraft Bus

Figure 6. WindSat Range Testing, Melbourne, FL

RESULTS

While WindSat's primary goal is to provide on-orbit verification of a polarimetric radiometer's capability to measure ocean surface wind vector prior to the launch of CMIS, there have been other benefits. These vary from the demonstration of a cost effective far-field antenna range for calibration to the testing of the NPOESS X-band capability prior to operational use.

IMPACT/APPLICATIONS

In addition to demonstrating the capability of measuring ocean wind speed and direction using a polarimetric microwave radiometer from space, WindSat data will enhance Naval real-time on-scene tactical support and battlespace awareness which enables tactical decision aids and increases mission planning effectiveness; reduce operations cost and increase warfighter safety through optimum ship routing and tropical cyclone avoidance; enhance accuracy of precision guided munitions; aid in potential avoidance of nuclear biological and chemical (NBC) agents; enhance surf index- amphibious assault and special operations; and aid in search and rescue operations. Additionally, this data will be provided to national and other military users.

Figure 7. WindSat Architecture

Figure 8. Titan II Launch, August 2002

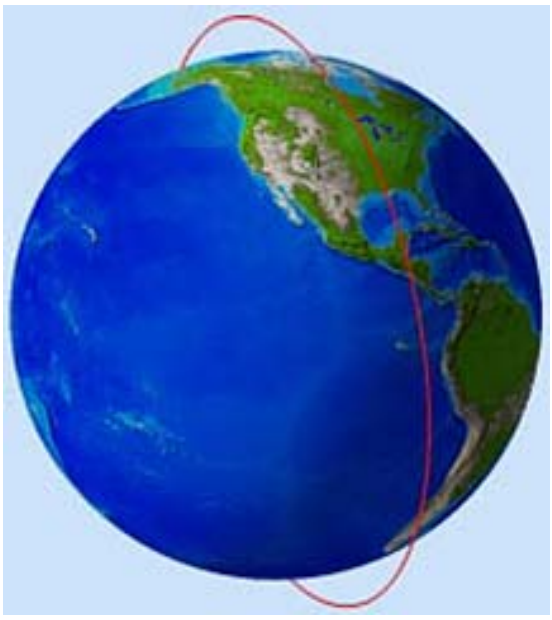

Figure 9. Coriolis Orbit

TRANSITIONS

The Department of Commerce/National Oceanic and Atmospheric Administration /Department of Defense converged NPOESS satellite program is providing a portion of the funds for the WindSat sensor as a risk reduction effort for the NPOESS planned CMIS project.

RELATED PROJECTS

CMIS will collect global microwave radiometry and sounding data to produce microwave imagery and other meteorological and oceanographic data. It will be the primary instrument for satisfying 20 NPOESS Integrated Operational Requirements Document (IORD) Environmental Data Records (EDRs).